

Solution Concentration Made Simple

The Analytical Lab Blueprint for Measuring Reactions

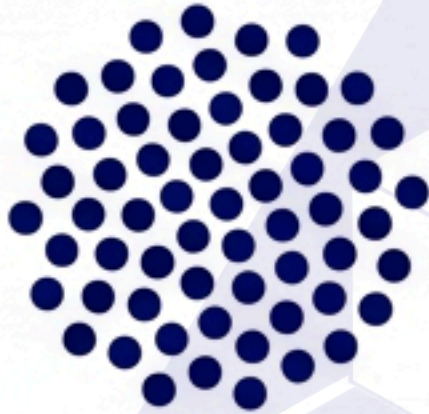
[Mass]

[Moles]

[Volume]



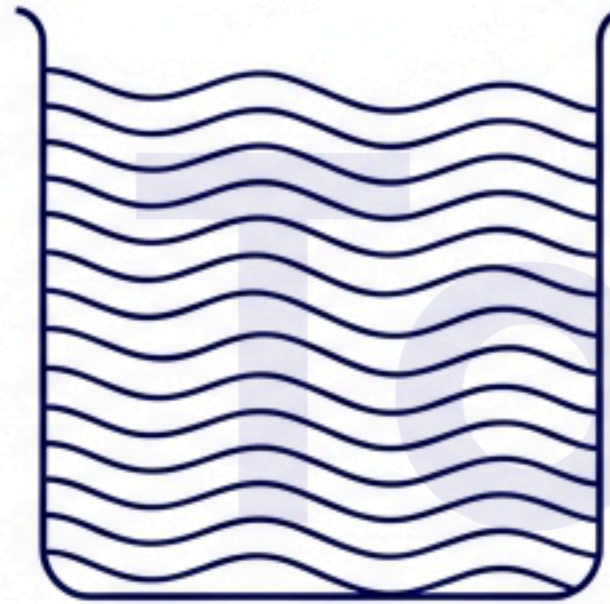
SOLUTE



The substance present
in the smaller amount.
It is dissolved.



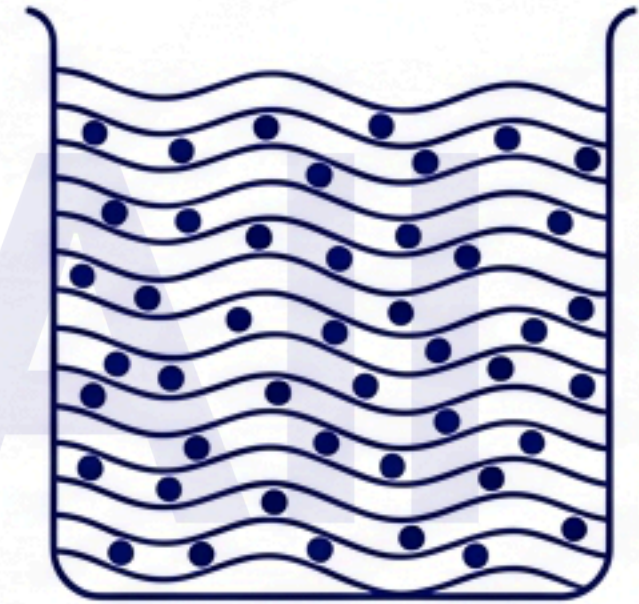
SOLVENT



The substance present
in the larger amount.
The dissolving medium.



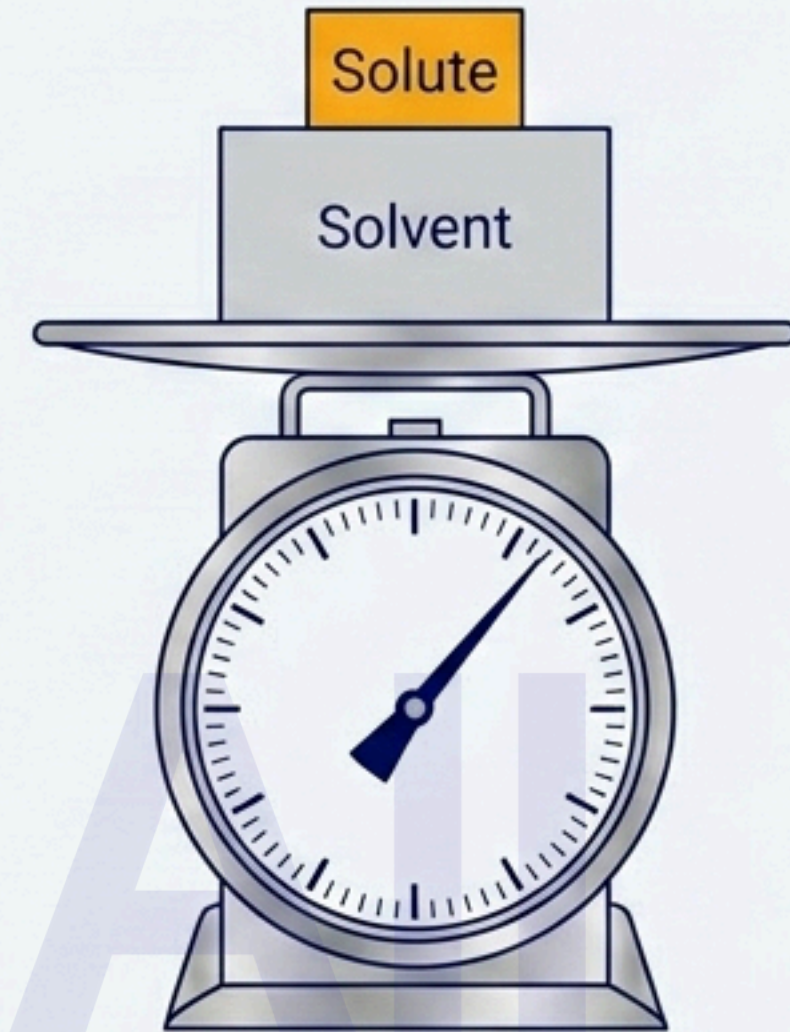
SOLUTION



A completely homogeneous
mixture where composition
is uniform throughout.

Tool 1: Mass Percent (w/w %)

$$\text{Mass \%} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$



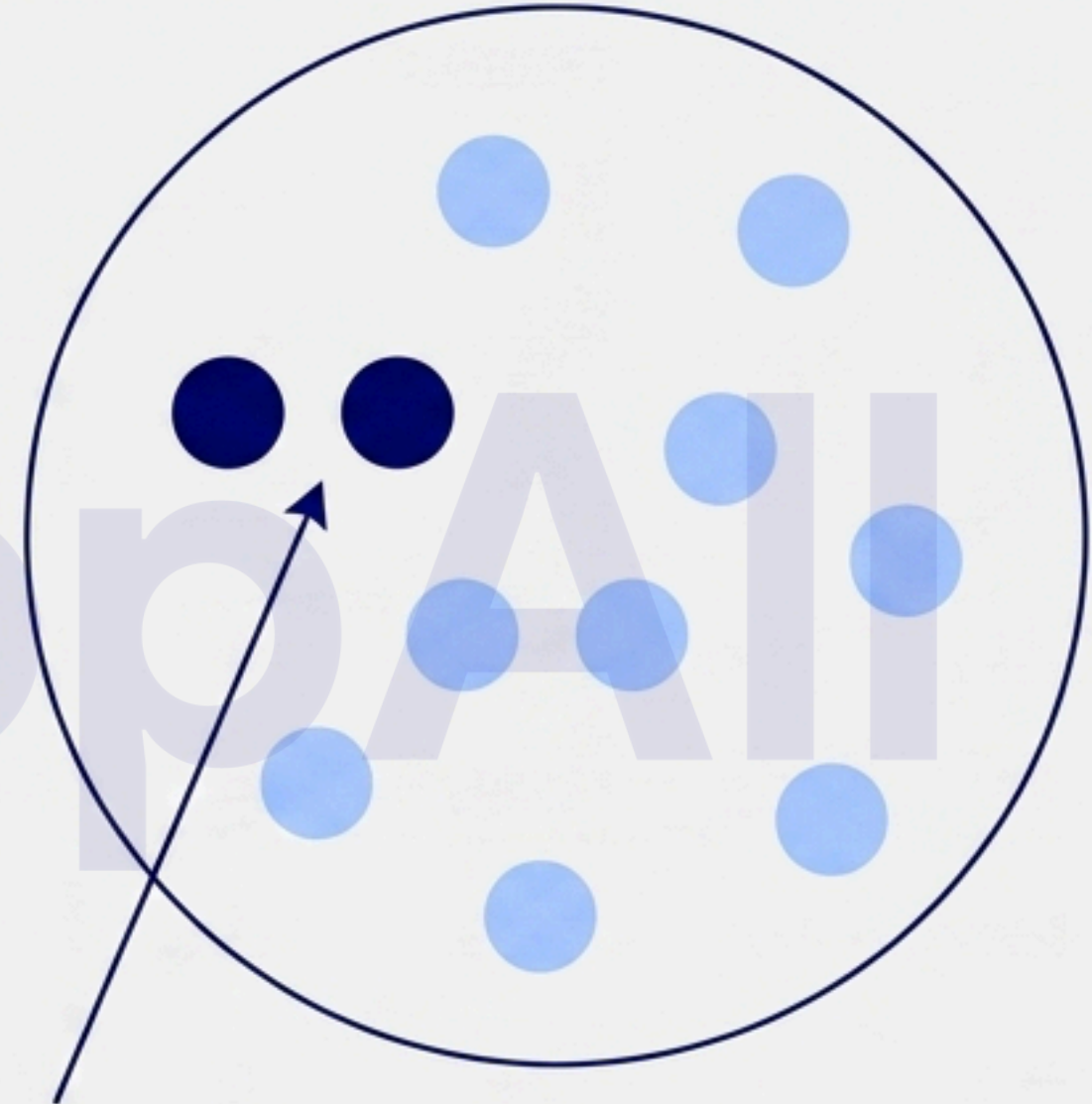
If 2 g of substance A is added to 18 g of water:

$$\text{Mass \%} = \frac{2 \text{ g}}{20 \text{ g}} \times 100 = 10\%$$

Tool 2: Mole Fraction (x)

$$x_A = \frac{n_A}{(n_A + n_B)}$$

Where n equals the number of moles of each component.

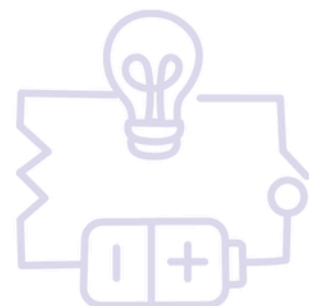


The ratio of the number of moles of a particular component to the total number of moles of the solution.



**You've Learned the Theory.
Let's Test Them Now.**

$$E=mc^2$$



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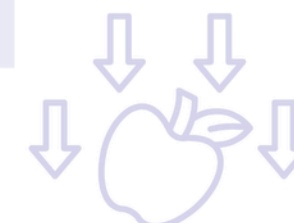
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Tool 3: Molarity (M)

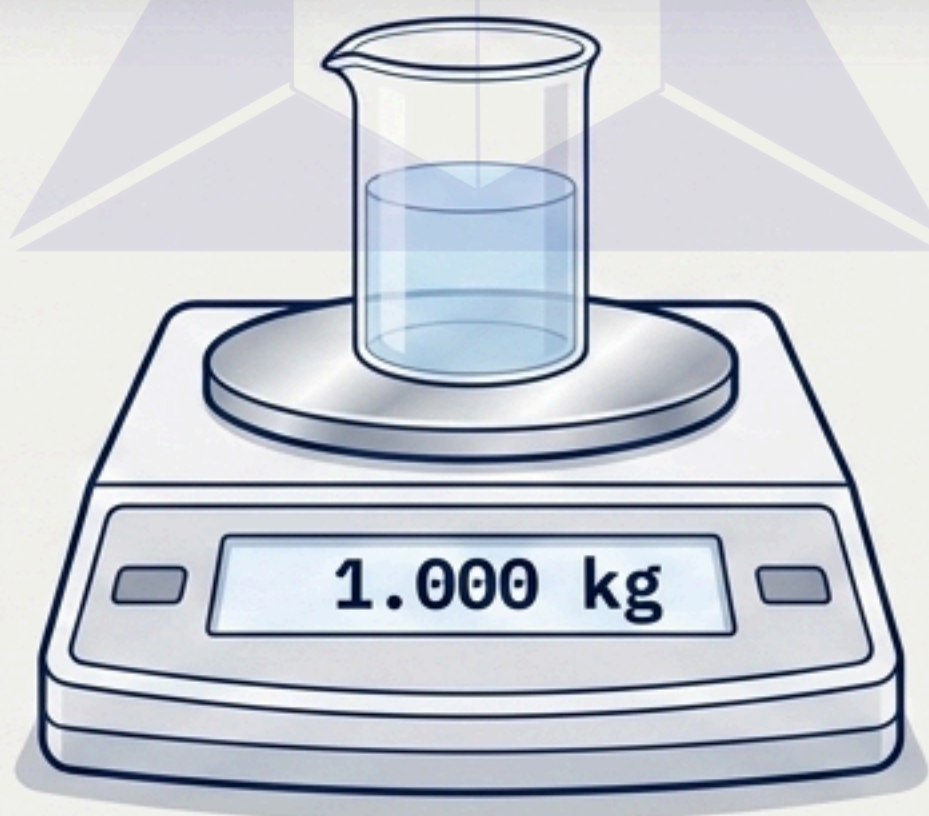
$$M = \frac{\text{moles of solute}}{\text{volume of solution in L}}$$



The most widely used unit in chemistry. It expresses the number of moles of solute present in exactly 1 Litre of the final solution.

Tool 4: Molality (m)

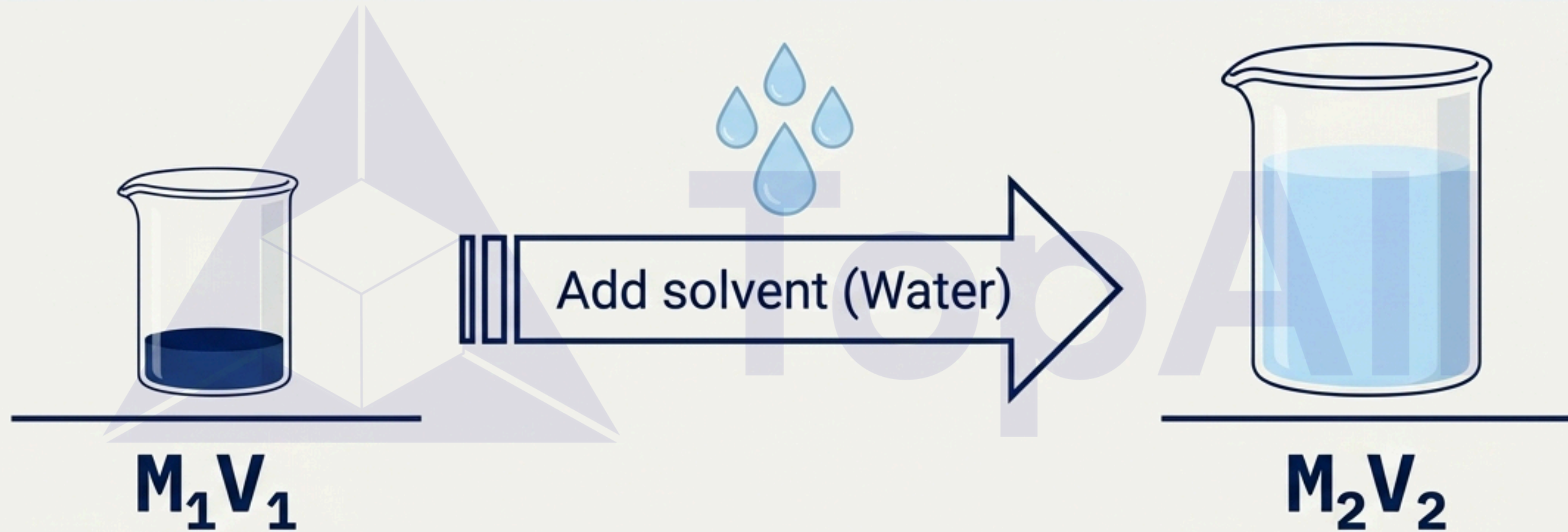
$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$



Defines the number of moles of solute present per 1 kilogram of solvent. Note the denominator uses mass (kg), not volume (L).

The Dilution Equation

THE GOLDEN RULE: Moles of solute do not change during dilution.



$$M_1V_1 = M_2V_2$$

Laboratory Application: Step-by-Step Calculations

Molarity: 4g NaOH in 250 mL solution

$$\begin{aligned}\text{Moles NaOH} &= 4\text{g} / 40\text{ g/mol} = 0.1\text{ mol} \\ \text{Volume} &= 250\text{ mL} = 0.250\text{ L} \\ \text{Molarity} &= 0.1 / 0.250 = 0.4\text{ M}\end{aligned}$$

Molality: 3M NaCl solution with density 1.25 g/mL

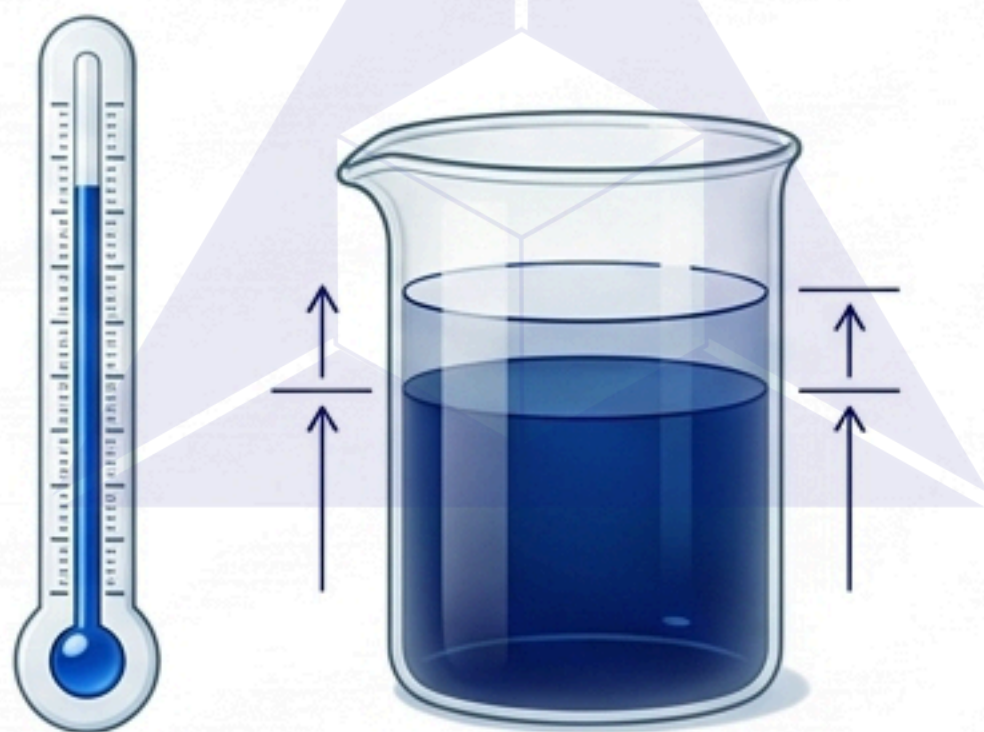
$$\begin{aligned}\text{Mass of 1L} &= 1000 * 1.25 = 1250\text{ g} \\ \text{Mass NaCl} &= 3 * 58.5 = 175.5\text{ g} \\ \text{Solvent} &= 1250 - 175.5 = 1.0745\text{ kg} \\ \text{Molality} &= 3 / 1.0745 = 2.79\text{ m}\end{aligned}$$

Key Takeaway: The Temperature Dependence Rule

[WARNING: TEMPERATURE SENSITIVE]

Molarity (M)

Depends on Volume.



Volume expands or contracts with heat. Therefore, the Molarity of a solution changes as temperature changes.

[KEY TAKEAWAY: TEMPERATURE INDEPENDENT]

Molality (m)

Depends on Mass.



Mass remains completely unaffected by temperature. Molality is the superior metric when heating or cooling a solution.



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